VINTAGE **RADIO**

BY ROGER JOHNSON

A Power Supply for Small Receivers

Although a very fine bench power supply for vintage radio was described in this column some years ago, many enthusiasts are now having difficulty finding the right power transformer for it. This month we give construction details for a flexible alternative supply which should assist.

ONE OF THE PROBLEMS that vintage radio enthusiasts have faced recently in building the power supply described by Peter Lankshear a few years back is the availability of a suitable power transformer. Unfortunately there is no one transformer that is going to fit the bill, but with the availability of small low cost transformers from the major electronics supply chains, it is possible to press two, or even three into service.

The aim of this article is to describe a power supply that can be built as a 'one-off' for a specific battery powered radio, yet remains flexible in its design so that it is suitable for other applications.

The new power supply is primarily intended for the plethora of 1.5 volt and 2.0 volt battery powered radios requiring 90 volts HT for the 1.5V valves and 135V for the 2.0V valves, respectively.

Radios using the later 1.5V series invariably dispensed with a grid bias battery. 'Back bias' or 'self bias' was incorporated into the circuit. The older series 2.0V valves may have required a grid bias battery. Some did, some did not. AWA receivers in particular had a chassis mounted grid bias battery.

The vast majority of four or five valve battery superhets chose the 1D4/1L5-G for the output valve, which requires only -4.5V bias for full operation. It would work quite satisfactorily on -6.0V with a saving in current drawn from the 'B' batteries.

In the circuit described, grid bias of up to -4.5V is obtained by the supply's own 'back bias' system, at the expense of total HT available. In so doing the cost and associated wiring of a third power transformer has been saved.

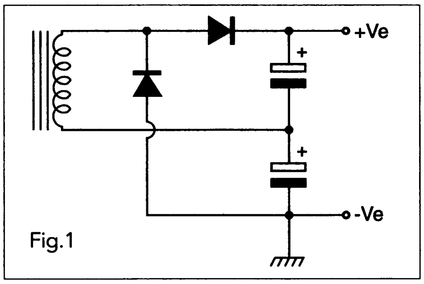
Power transformers

A transformer with a secondary of 120V or so at about 50mA would be ideal, but they are not easy to find. Or cheap, if you can find them...

A power transformer from a discarded valve chassis has its own problems. Firstly, there is the size and associated mounting problems. More importantly, though, is the fact that the secondary voltages are far too high. Even 280V a side poses problems, and the old 385V-0-385V jobs are simply out of the question for this project. The biggest problem is divesting the large voltages that need to be dropped in order for the valves to work at 90 to 135 volts HT.

To buy a new transformer capable of being used to deliver the required voltages, requires something a little unorthodox in vintage radio terms.

Fig.1: The full wave voltage doubling rectifier circuit which was popular towards the end of the valve era.



Voltage multipliers

Towards the end of the valve era, 'voltage doubler' rectifier circuits incorporating silicon diodes were used instead of the hefty valve rectifier (Fig.1). The extension of the voltage doubler is the *quadrupler*, and that is the circuit that we're using here. The circuit is shown in Fig.2.

Basically, this type of circuit involves successive charging of the storage capacitors, via the duty cycle and polarity of the diodes, such that C4 is constantly under charge whilst a load is being drawn from it. The voltage at C4 is the transformer voltage plus the stored voltage in C3, which is charged up to three times the transformer voltage, by 'charge pump' action via C1 and C2 — charged at one and two times the transformer voltage respectively.

The performance of this type of voltage-multiplying rectifier boils down to getting as large a capacity as is possible and practible, especially for C4. The higher the load current, the greater is the capacity required. 47uF is about the minimum for this project.

The recommended voltage ratings needed for capacitors C1 to C6 respectively are tabulated alongside the circuit. C2 should have a rating of at least 90V, but you could use either a 250V unit or connect two 100uF/63V units in series, with a 27k resistor in parallel with each to ensure they share the voltage drop equally.

47uF/250V electrolytics are available (Cat No. 267-4906) from RS Components, which has warehouses in most capital cities. This firm also stocks a 47uF/100V unit Cat No. 267-4827), which could be used for C2.

Jaycar Electronics stores also stock 47uF/450V and 100uF/450V electrolytics, as well as 47uF/63V and 100uF/63V types which could be used for C1. The 450V units could be used for C4-6 if you can't get 250V capacitors.

Regulation

The output from the basic voltage-multiplying rectifier circuit across C4 in Fig.2 has a way to go before it can be used. Superimposed on the high voltage DC is a mighty fine sawtooth waveform, of considerable amplitude. However with sufficient filtering and zener diode regulation, the end result is quite satisfactory.

To begin with, filter resistors R1A and R1B are most important, together with filter capacitors C5 and C6. Zener diodes ZD1-4 are then used to regulate the output.

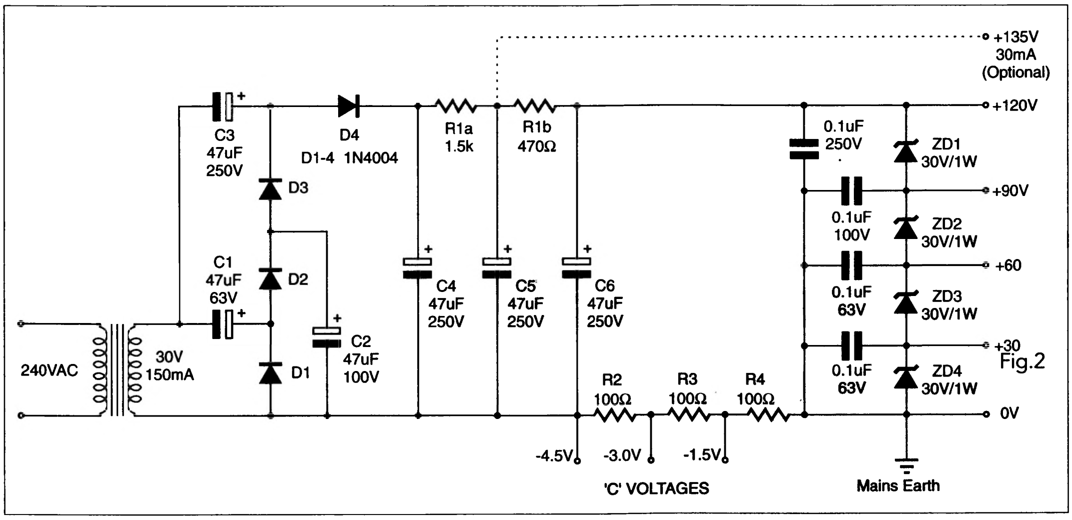


Fig.2: The final circuit for the 'B' and 'C' sections of the author's supply, giving a range of HT and bias voltages. As you can see it uses voltage quadrupling to provide up to 135V from a 30V transformer.

The author's completed prototype supply, housed in a low cost plastic jiffy box. It's likely to cost between $40 and $50, depending on the options you want.

The value of the filter resistor must be within quite defined limits. When using a proprietary line transformer such as the MM2007 which is rated at 150mA, we must consider the overall secondary power, and tailor the secondary current accordingly. As we are asking this transformer to deliver four times the voltage, the current can only be one fourth of the rated value. This limits the current to 38mA, which in this case is more than the amount drawn by the zeners.

Depending on the value of capacitors and the value of the filter resistor, slightly more that 120 volts may be available at the output. In any event, after filtering, 120 volts is available for the supply. For a radio requiring 135 volts, this slight reduction will not make a scrap of difference.

The filtering is most important. Initially, 200mV ripple was produced, which was considered high. With the circuit shown the two-stage RC filter delivers an almost negligible 25mV under full load of 14mA. The resultant bleed current is 17mA, well within the limits of the transformer and the zeners.

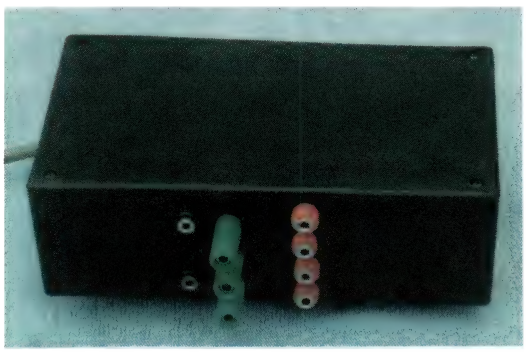
The small resistors R2, R3 and R4 provide a small voltage drop in the negative rail of the supply to allow for grid bias. The '0V' reference is taken from the junction of R4 and ZD4. The bias voltages are -1.5V, -3.0V and -4.5V, which will suit any set requiring -1.5V for delayed AGC and -4.5V bias for the output stage.

To increase the flexibility, the values of these resistors can be increased to produce higher bias voltages. The calculations are simple enough, so I'll leave them to you.

The filament supply

So far, of course, we've only considered the HT and bias supply. Now let's turn to the filament supply. Here a separate transformer is used, together with an LM317 variable regulator (Fig.3).

By the way these devices are NOT indestructible, despite what may be claimed, and they do run hot. The higher the voltage differential between input and output, the hotter they run. Despite being rated at 1.25 amps, the closer the load current to the maximum and the



closer the output voltage to the input, the more likely they are to both fail to deliver the required output voltage, and also to generate substantial ripple.

When you're working out the transformer secondary voltage needed for this supply, remember that for all practical purposes, the raw DC after rectification will be the peak voltage of the transformer secondary (about 8.9V), less two diode drops from the bridge rectifier (1.2 volts) and at least 2.5 volts which must be allowed for 'headroom' in the regulator chip. So with a typical 6.3V/1A transformer, the maximum output is around 4.0V.

This has been borne out in practice. Under heavy load, about 0.75 amp, the device then will fail to deliver even 4.0V (with the 6.3V AC input) and heavy ripple appears on the output. However, for a 1.5V or 2.0V output, a 6.3V transformer such as the Jaycar MM2002 should be fine.

The regulator should be fitted with a small heatsink, or at least mounted on a suitable area of copper on a PCB. This has been done in the prototype shown in the photos, and it's a wise precaution.

The LM317 regulator is usually used with a variable resistor to set the feedback voltage, and hence the output voltage. However some people (myself included) have a preference for a switched voltage, instead of a continuously variable output; but herein lies a snag.

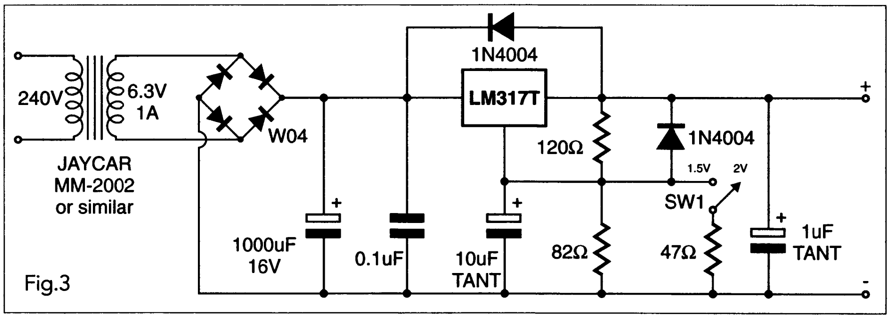
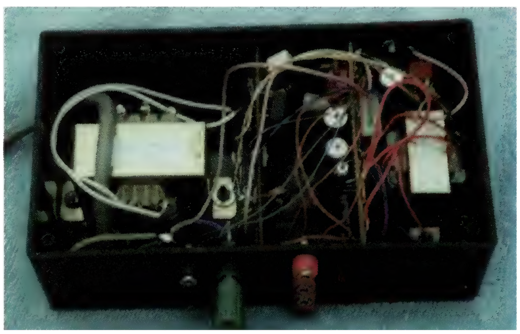


Fig.3: The low voltage filament or 'A' supply, delivering regulated DC of either 1.5V or 2.0V at up to about 750mA.



Inside the prototype, showing the two transformers and the two separate stripboard assemblies — one for the HT/bias supply and the other for the filament supply.

During the interval when the switch wiper passes from one contact to another to select an appropriate resistor, there is no feedback voltage applied to the device. Experience has shown that this action could have a deleterious effect on the device, and may explain the reason why they unexpectedly fail. When I changed over temporarily to a continuously variable output, the problem didn't occur.

For this project, a simple toggle switch connecting a shunt resistor across the lower divider resistor has been used. This allows the output to be set to either 1.5V or 2.0V with no problems. The upper divider resistor is the standard 120 ohms, with the lower resistor 82 ohms for 2.0V and shunted down to 27 ohms (via the 47 ohm resistor) for 1.5V.

Strictly speaking the 1.5 volts should be 1.4 volts, but as these valves were intended for dry batteries whose terminal voltage when new is 1.56 volts, any figure between 1.4 and 1.5V should suffice.

Construction

The project has been designed to fit all components into a 197 x 113 x 63mm jiffy box. Two PC boards could be used, or if you wish it can be built on 'stripboard' like the prototype. Whichever is used should slide vertically into the locating grooves.

The zener diodes will get hot. Half-watt types are specified, and it is a good idea to leave the leads as long as possible (say 1") to allow the passage of air to cool them a little. To this end, it may also be a wise precaution to drill ventilating holes one each side of the box, and one or two 6mm holes in the top as well.

As for the terminations, there is a good deal of flexibility. If it is to be used for a specific receiver, the battery leads of that receiver may be hard wired. However, as many constructors may wish to use the supply to power a variety of radios, the terminations can be to a variety of coloured banana sockets conveniently mounted. The number may depend on your degree of flexibility. A suggested set would be B- (black) and a set of four red sockets marked B1+ (30V), B2+ (60V), B3+ (90V) and B4+ (120V) respectively. The filaments can be red and black, placed near the 1.5V/2.0V toggle switch.

The grid bias can be in the conventional colours of C+ (white) and then three green terminals marked C1- (-1.5V), C2- (-3.0V) and C3- (-4.5V) respectively.

Remember also to secure the incoming power cord with a suitable clamp. The mains earth wire should be connected to the frame/mounting flange of each transformer, and also to the B-/C+ output terminals.

Flexibility

The circuit for this supply is more flexible than you might think. For example should 4.0V or 6.0V filament power be required for the much older sets using those series of valves, you can achieve this quite easily by changing resistor values in the regulator circuit of Fig.3. The lower divider resistor is increased from 82 ohms to 470 ohms to give just over 6.0V of output, while the

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nearest shunt resistor value for 4.0V is 560 ohms (which should give about 3.9V). Alternatively, a 1k trimpot may be used for more accurate adjustment. The 12.6 volt tap will need to be used on the transformer, and the remainder of the circuit remains the same.

As long as the filament voltages are within +/-0.1V to 0.3V, depending upon the value chosen, all should be well. It must be remembered that these radios were originally powered by lead-acid accumulators, and one cell fully charged was 2.2 volts. The radios generally 'gave up' when the battery terminal voltages fell to something in the order of 60% of the fully charged 'new battery' value. So the tolerance is reasonably wide.

There's only one real precaution: DO NOT run the filaments of 1.5V valves at ANY HIGHER than 1.5 volts. They simply will not take it!

As another variation on the supply, people wishing to experiment with one- and two-tube receivers using indirectly-heated 6.3V/0.3A 'AC' valves such as the 6SN7 twin triode might be able to use just an MM 2002 transformer alone, to provide an economical 'single power pack' for both the heater power and HT. (As the transformer is rated at 1A, though, it would not be wise to run more than three heaters.)

The full 15V secondary voltage can be connected to the voltage quadrupler, and with only two 22V zeners you should be able to obtain 45V to run one of these little receivers for headphone use. Although the 0V will be common to both the heater and HT supply, this won't be a problem using indirectly heated valves. Of course you won't need the filament rectifier or regulator for these valves.

Depending on what one can find in the junk box, the cost of this little project may be as low as $40 for the two power transformers, jiffy box, regulator and heatsink, stripboard and the higher voltage electros. Have fun! ■